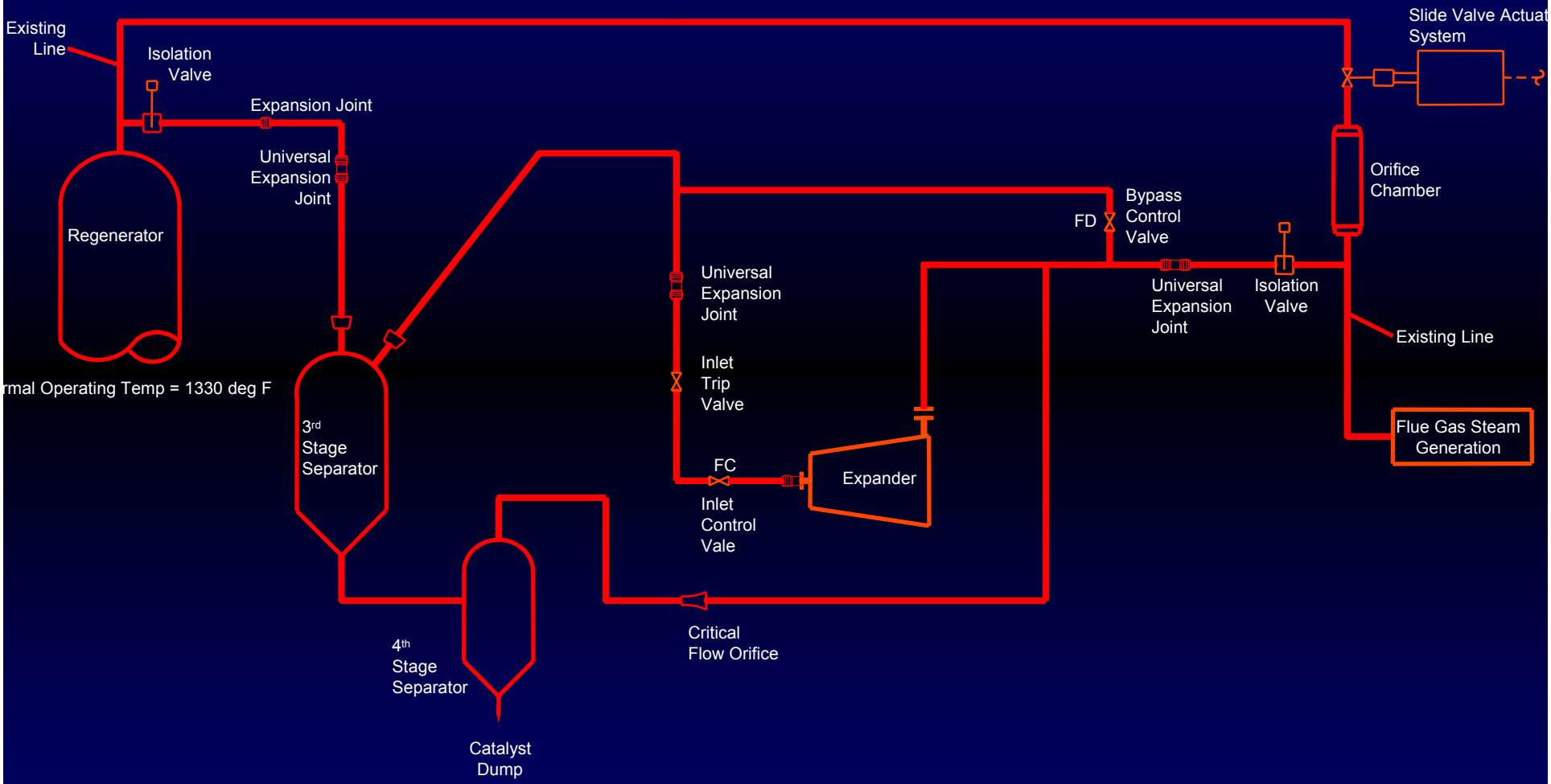
VALERO REFINING COMPANY

VALERO, Houston
FCCU Power Recovery Train Rerate and Upgrade

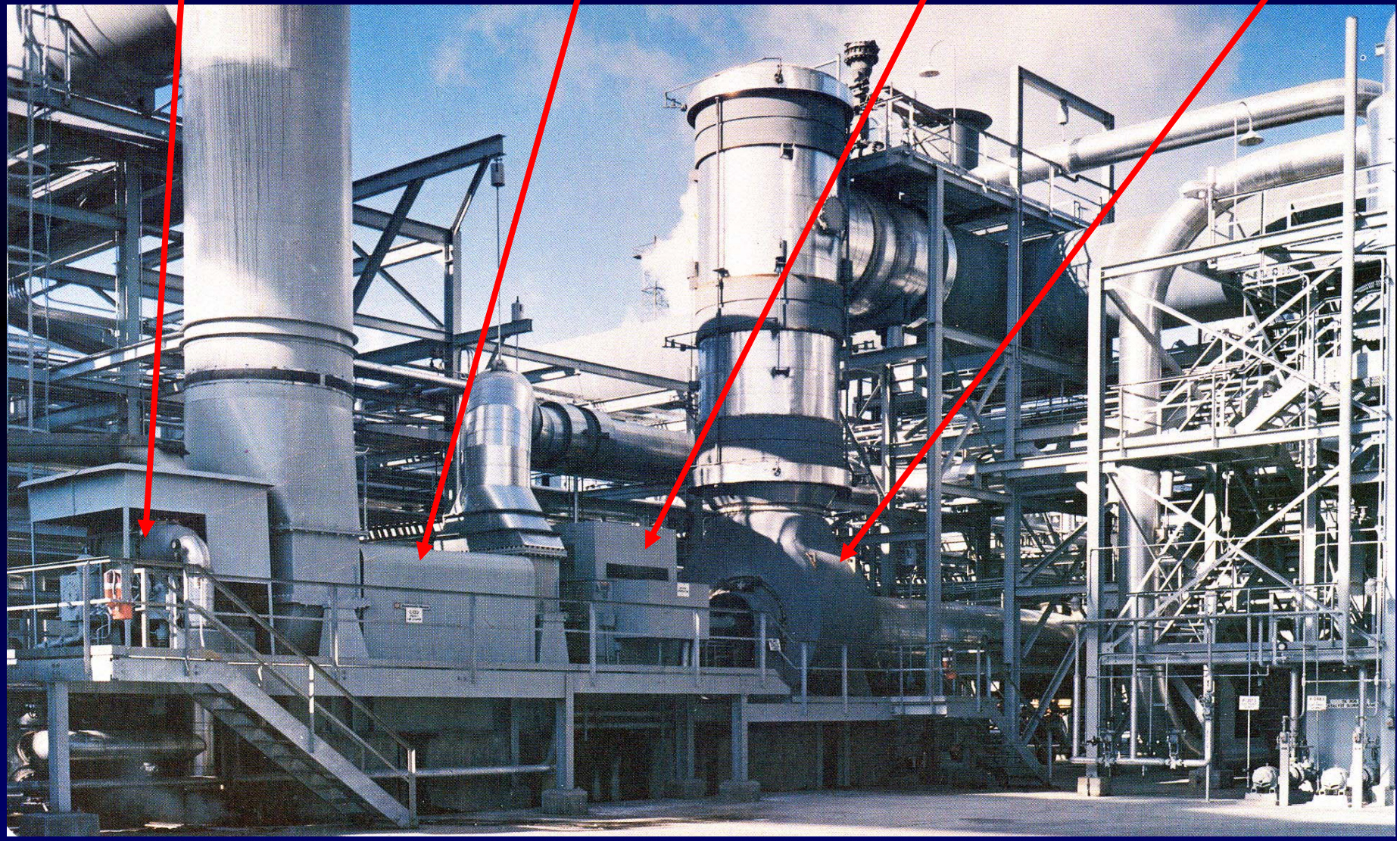
GEPS Oil & Gas

FCC Unit Flow Diagra



Typical Power Recovery Train

Steam turbine – Axial compressor – Motor/generator - Expander

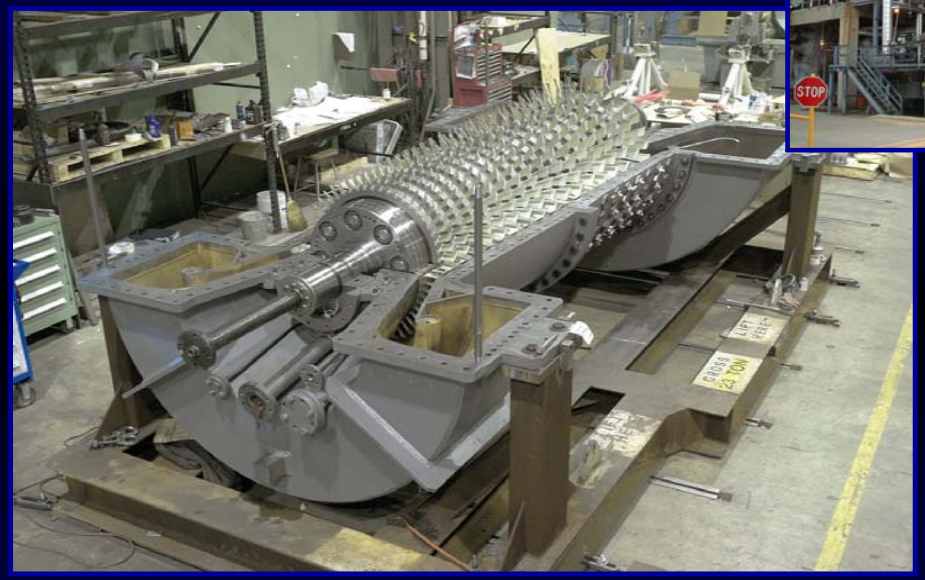


Valero Houston PRT Rerate/upgrade
Key Job Considerations

- **FCCU plant expansion requires more air flow and pressure.**
- **Train power increase can be accommodated by rerating expander for increased flue gas.**
- **Steam turbine can be rerated to accommodate higher starting power requirement while increasing reliability.**
- **Equipment foot prints and shaft end spacing must not change.**

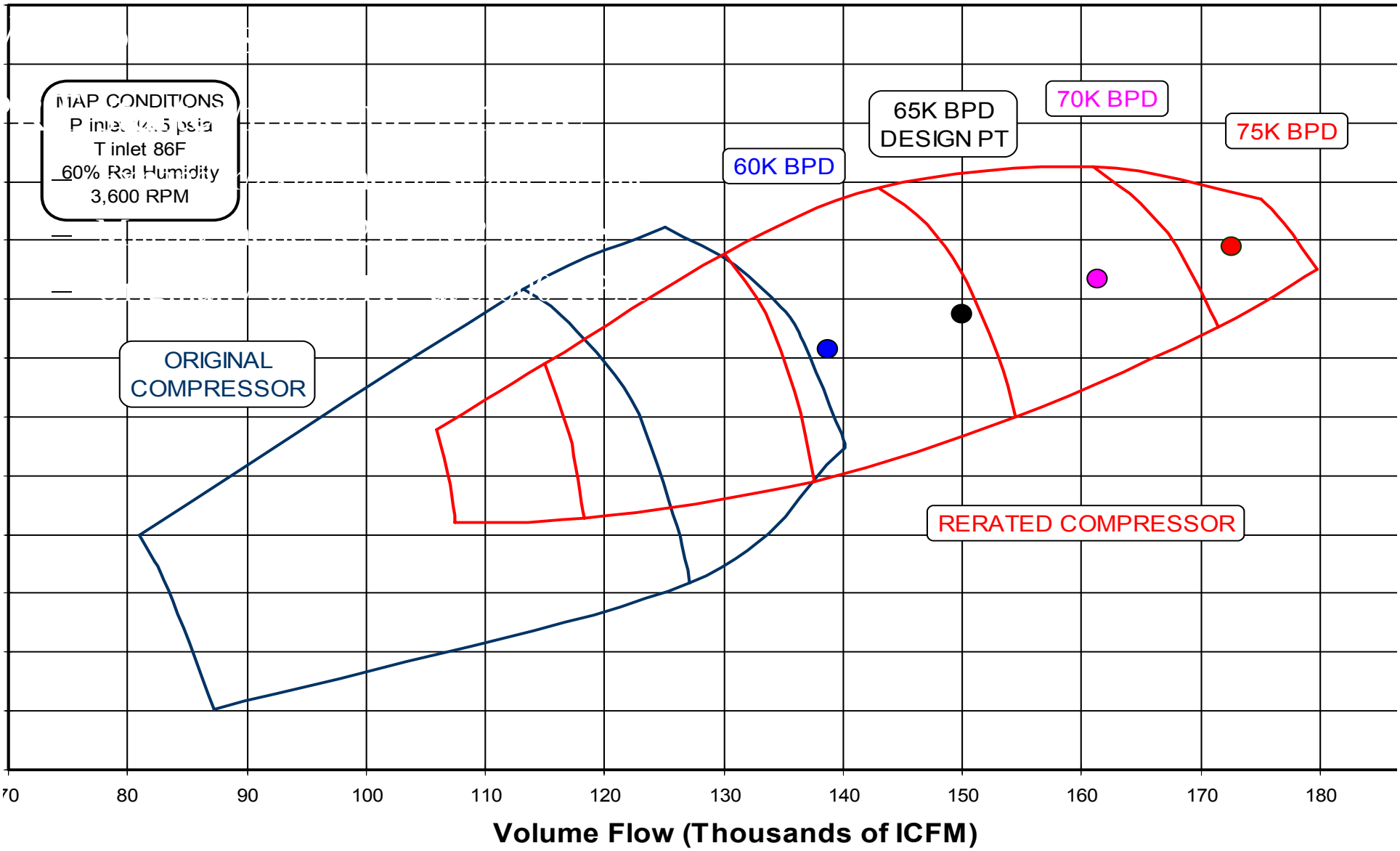
Valero Houston FCCU PRT Main A
Blower Rera

- Reapplication of surplus axial.
- Redesigned from 15 to 17 stages.
- Rerated for additional 30% flow capability.



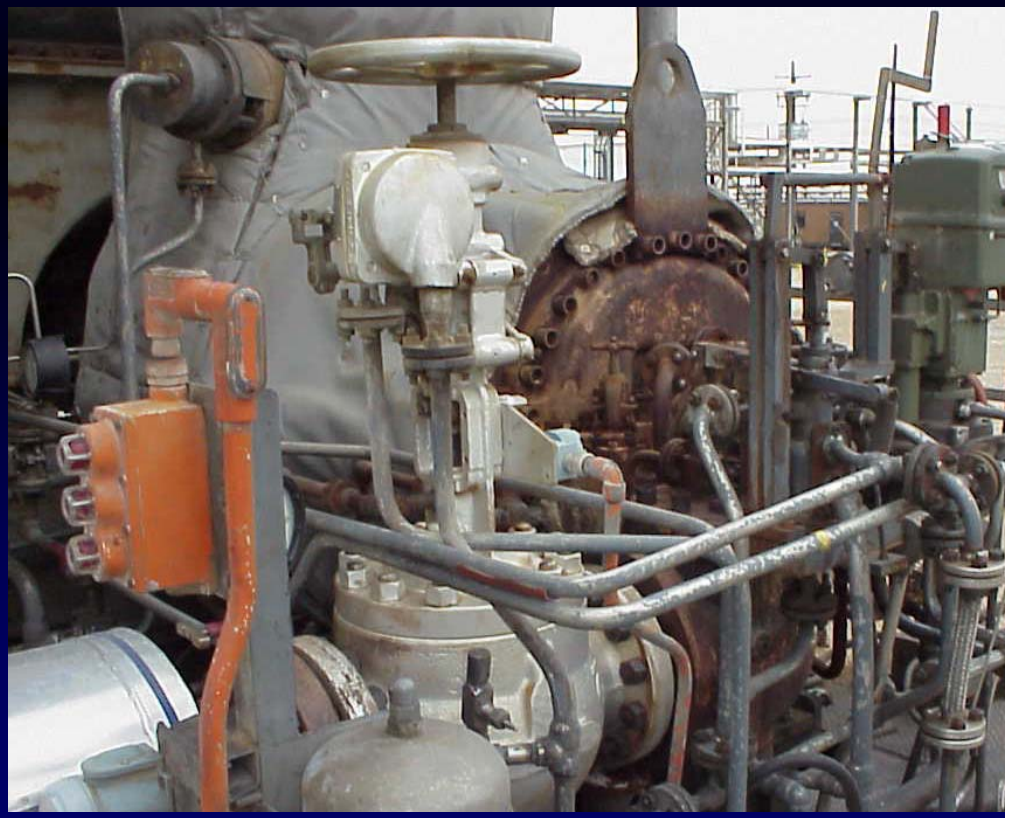
Unit during final assembly

AXIAL COMPRESSOR ESTIMATED PERFORMANCE
ORIGINAL VS. RERATE



PRT Starter / Makeup Turbine

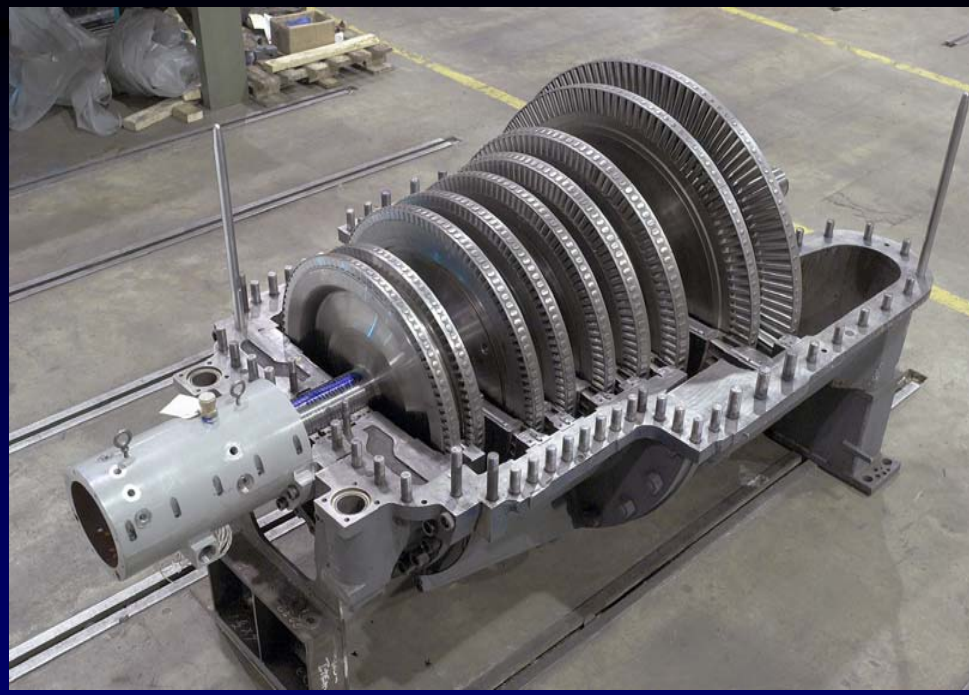
- Expander/axial/motor/steam turbine
- Originally 6,000 HP at 3,600 RPM



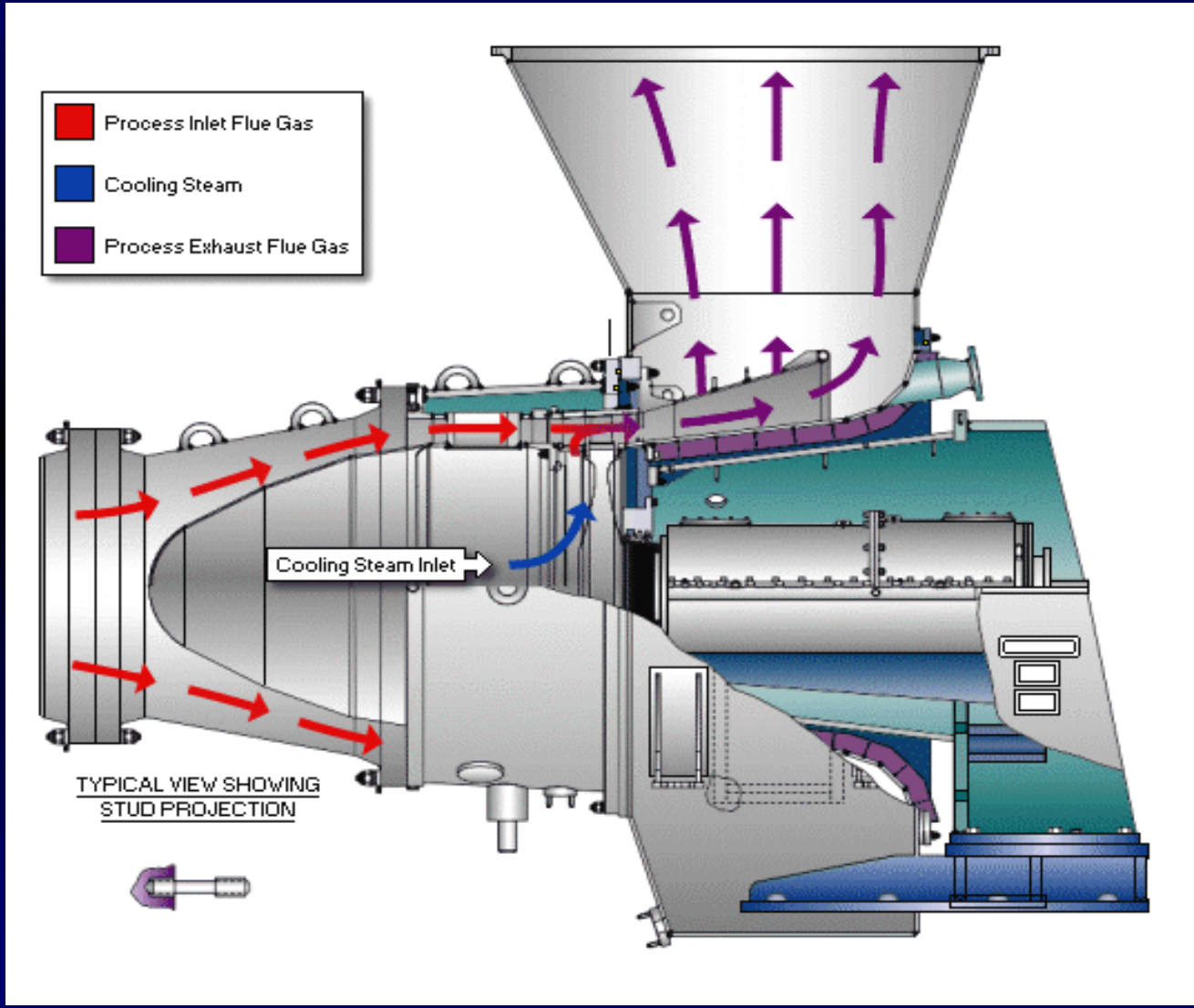
PRT Starter / Makeup Turbine

- **Rerated to 12,000 HP**
- **100% increase in power**
- **Integral rotor in lieu of original**

  Built up rotor



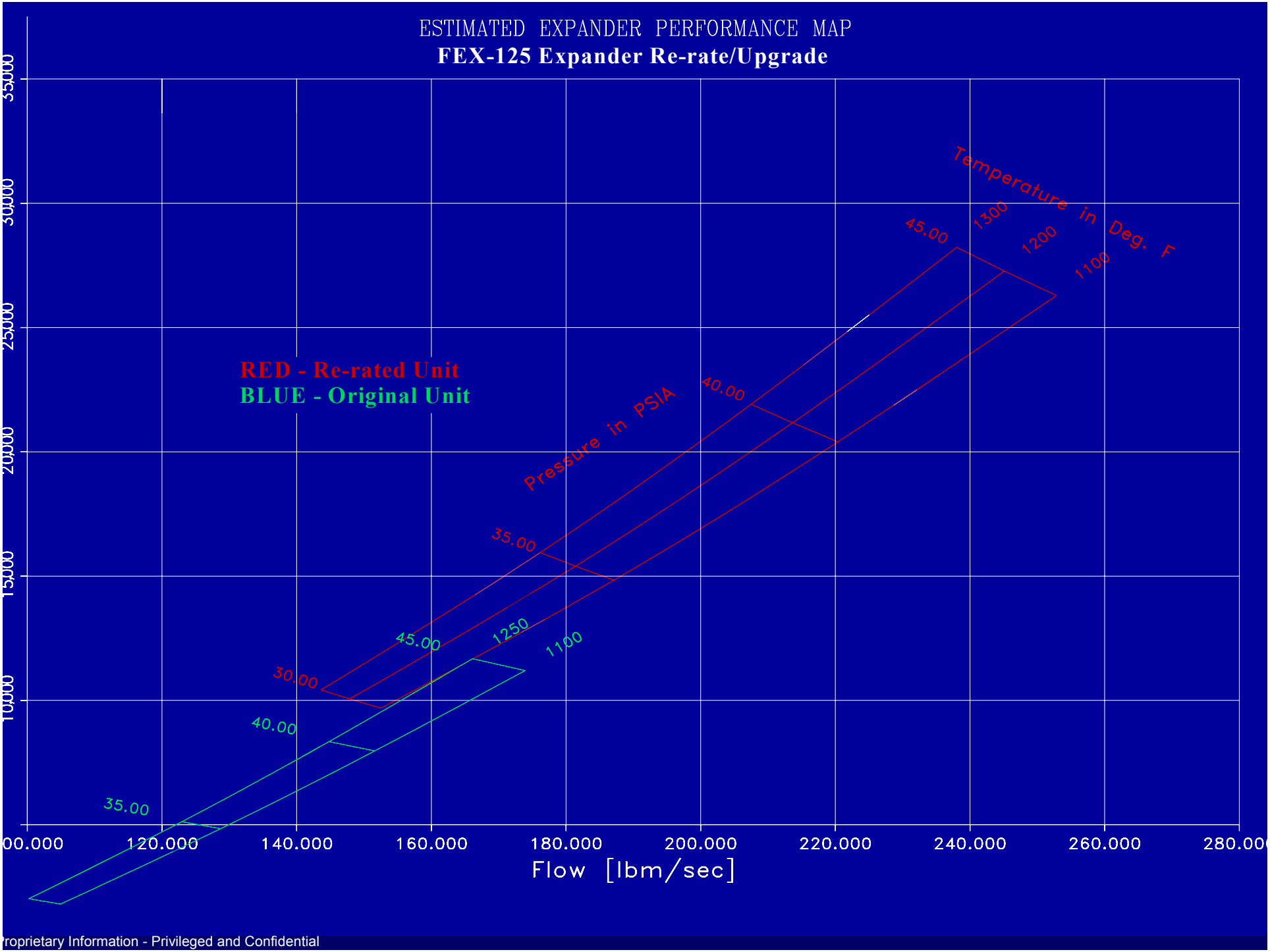
Typical FCC Expande



Valero Houston Hot Gas Expande
Rerate Detai

CONMEC FEX-125 INTAKE ASSEMBLY

- **Reapplication of surplus/unused unit**
- **Increased HP by over 50%**
- **Upgraded rotor design for increased HP**

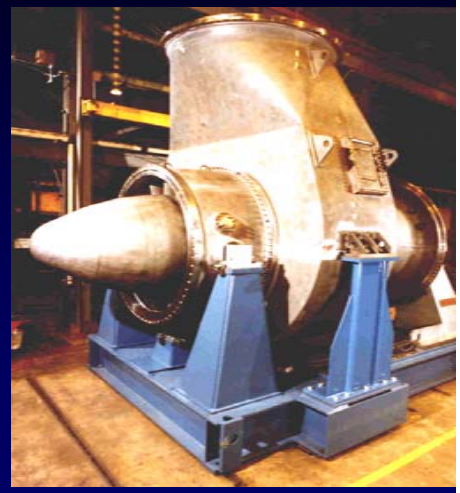


FCC Power Recovery: Expander/generator Sets

GE CONMEC
Bethlehem, PA
USA

Unique Turbine Application

- **FCC expanders operating conditions:**
- Low pressures (< 30 psig)
- High temperatures (1100 to 1400 degrees F)
- High volume flow (> 1,000,000 lbs/hr)
- High power density turbines (1,000 Hp per blade)
- Unique installation requirements (such as large ducting)
- Must operate continually for long periods of time > 32,0000 hours



Installation Options

- **Expander Installation Options:**

- **Addition of an expander to the current air blower train**
  - Expander
  - Motor/generator

- **Installation of a stand along expander / generator set**

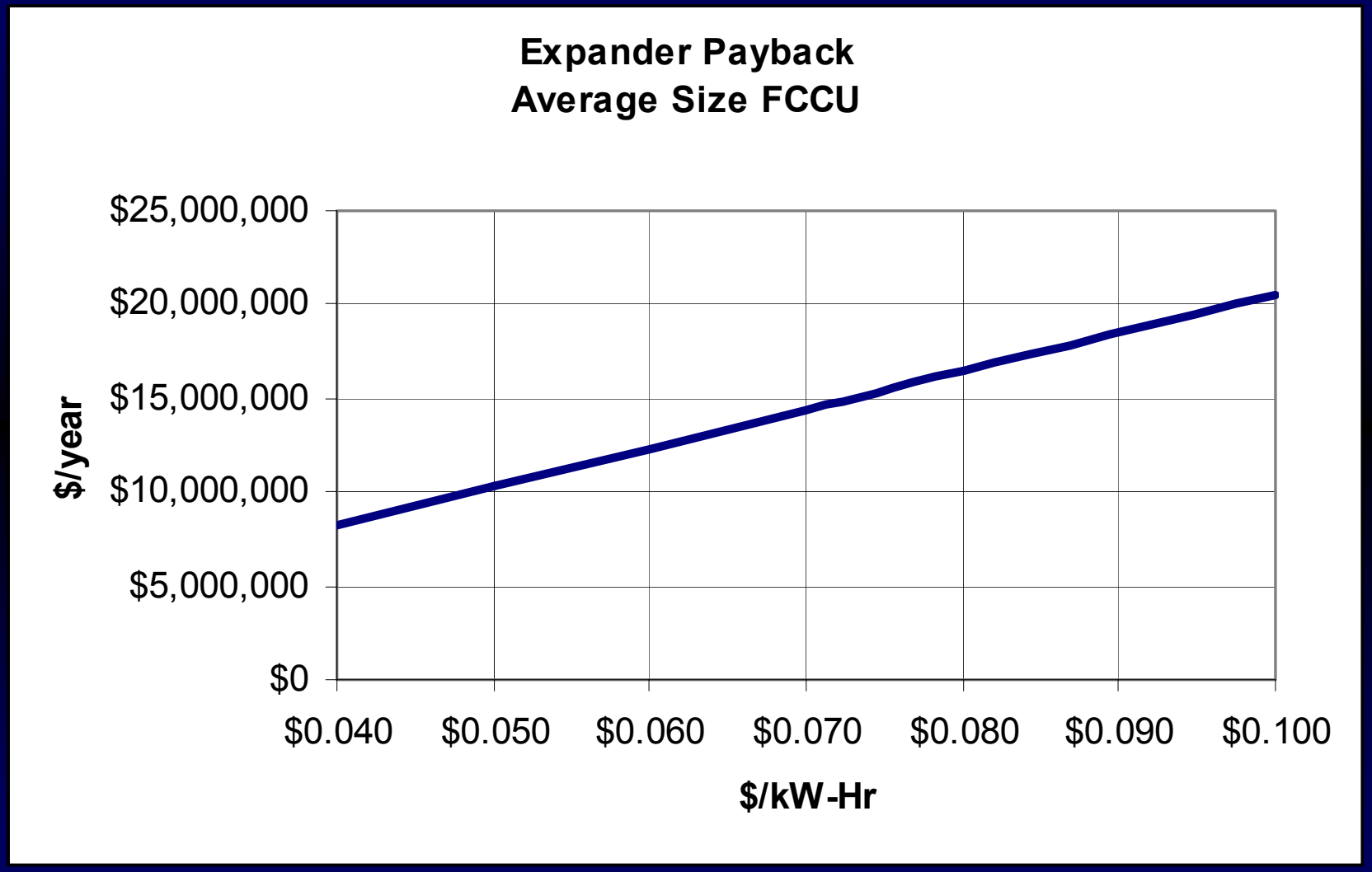
Installation Requirement

- **Plot Space**
- **Third stage separator**
- **Piping**
  - Stainless steel unlined piping
  - Expander inlet
  - Expander bypass
- **Control system**
  - Hot Valving
  - Isolation
  - Process controls
  - Generator controls

- **Tollgate 1: Feasibility Review**
  - (Customer to provide the following information)
    - Regenerator temperature
    - Regenerator pressure
    - Regenerator flue gas flow rate
    - Electricity costs
    - Steam costs

- **From this information GE CONMEC can estimate**
  - Power recovery
  - Frame size of expander
  - Reduction in annual energy costs

Expander Payback

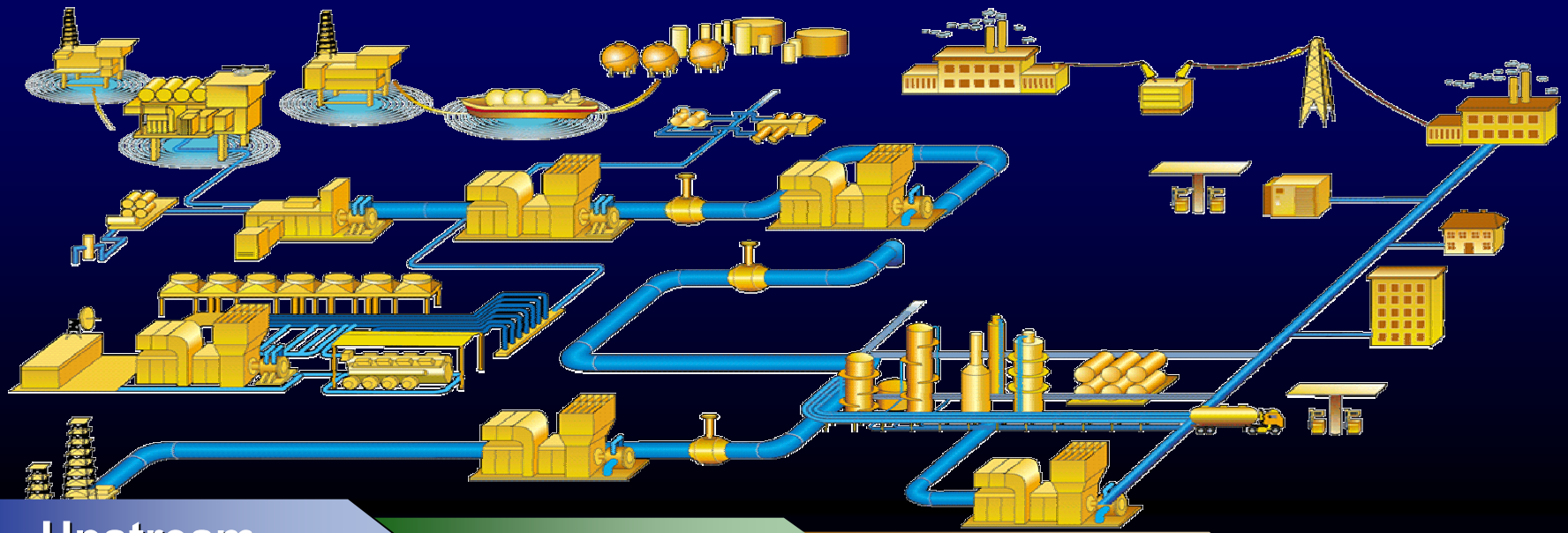


VALERO REFINING COMPANY

Valero/GE Conmec projects in production

- Corpus Christi expander power upgrade
- Wilmington expander reliability upgrade
- Wilmington axial compressor reliability upgrade
- Ardmore FCCU wet gas train upgrade
- Paulsboro Hydrogen recycle compressor upgrade

GEPS Oil & Gas — Oil & Gas Industry Value Cha



Upstream | Midstream | Downstream | Distribution

Industrial Plants

Global Services

Drivers

- GT Efficiency & Fuel Flexibility
- Environmental Compliance
- Increasing Gas Production
- Service Response Time
- Reduced Life Cycle Cost

Offerings:

- Fuel Conversions & Upgrades
- Emission Reduction Technology
- Turbo-Compressor Upgrade
- Local Presence … US Footprint
- CSAs & RM&D

GEPS Oil & Gas Services Leadersh

Nuovo Pignone
Center Of
Excellence for:
- Compressors
- Gas & Steam Turbines
- Reactors
- Air-Coolers
- Pumps - Valves
- Metering Systems
- Fuel Dispensers (L & G)

Rotoflow
Center Of
Excellence for:
- TurboExpanders

Thermodyn
Center Of
Excellence for:
- Low to Medium Pressure Compressors
- Low to Medium Power Steam Turbines

Gemini
Center Of
Excellence for:
- High Speed Recip

AC Compressor
Center Of
Excellence for:
- Screw Compressors
- Single Stage Centrifugal
- Custom Centrifugal
- Rotary Vanes

CONMEC
Center Of
Excellence for:
- Multi-vendor Services:
  - Power Turbines
  - Hot Gas Expanders
  - Centrifugal & Axial Compressors
  - Steam Turbines

Odessa
Center Of
Excellence for:
- 3rd Party GT Service